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HIGHWAY MORTALITY OF BARN OWLS IN NORTHEASTERN FRANCE

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ABSTRACT.—We found a total of 187 road-killed raptors along a 150 km stretch of highway in northeastern France between 1990–94. Of these, 148 were Barn Owls (*Tyto alba*), 15 Long-eared Owls (*Asio otus*), and 10 Tawny Owls (*Strix aluco*). We analyzed different variables including the topography of highways, the types of habitats crossed by highways, and the types of vegetation along highways to determine why so many Barn Owls were killed. Most mortalities (64%) occurred along embanked stretches that crossed open fields and lacked hedges on either side. We concluded that the local population density and flight behavior of Barn Owls were probably related to such high mortality.

KEY WORDS: *Barn Owl*; Tyto Alba; *highway mortality.*

Mortalidad de *Tyto alba* en autopistas del noreste de Francia

RESUMEN.—Encontramos un total de 187 aves rapaces atropelladas a lo largo de un segmento de 150 km de autopista en el noreste de Francia entre 1990–94. De estas, 148 fueron *Tyto alba,* 15 *Asio otus* y 10 *Strix aluco,* para un total de 173 aves rapaces nocturnas. Analizamos las diferentes variables incluyendo la topografía de las autopistas, el tipo de habitats atravezados por la autopista y tipos de vegetación con el fin de determinar las causas de mortalidad de *Tyto alba.* La mayoría de las muertes (64%), ocurrieron a lo largo de terraplenes angostos que cruzaban sitios abiertos sin arbustos a los lados. Concluimos que la densidad poblacional local y el comportamiento de vuelo de *Tyto alba* estaban probablemente relacionados con esta alta tasa de mortalidad.

[Traducción de César Márquez]

Studies indicate that large numbers of raptors, especially Barn Owls (*Tyto alba*) are killed along highways in Europe (Baudvin et al. 1991, de Bruijn 1994, Taylor 1994). In France, there is a predominance of owls killed and, although the numbers vary according to region, Barn Owls (*Tyto alba*) are most commonly killed (Bourquin 1983, Joveniaux 1986, Athanaze 1992). Most Barn owls are killed in autumn and winter (Joveniaux 1986, Athanaze 1992, de Bruijn 1994, Taylor 1994), but there is also a high mortality along highways during the post-fledging period. Whereas the temporal variation in Barn Owl mortality has been shown, little information is available on the spatial variation in mortalities or the causes of death (Joveniaux 1986, Athanaze 1992). Here, we present the results of a study designed to show how such variables as the landscape crossed by the highway, the topography, and the vegetation along the roadway affect Barn Owl mortality.

MATERIAL AND METHODS

Raptors killed by vehicles were collected along a 150-km section of a highway between Strasbourg and Metz (northeastern France) over a 5-yr period (1990–94). In the case of dead Barn Owls, the location of carcasses on the highway was noted as either in the emergency stopping lane, the traffic lanes, or the median strip. We also noted the landscape crossed by the highway (forest, open field including cultivated fields, wasteland, bogs, and concrete), the topography, and the type of vegetation along the sides of the highway. Because Barn Owls fly at an average height of 5 m (Baudvin 1986), we classified this section of embanked and excavated highway (Fig. 1) into the following classes: highly embanked (≥5 m elevation on at least one side), shallow embanked (1–4 m elevation on at least one side), level highway, shallow excavated (1–4 m excavation on at least one side), deeply excavated (≥5 m excavation on at least one side), and embanked/excavated (height not distinguished). Vegetation along

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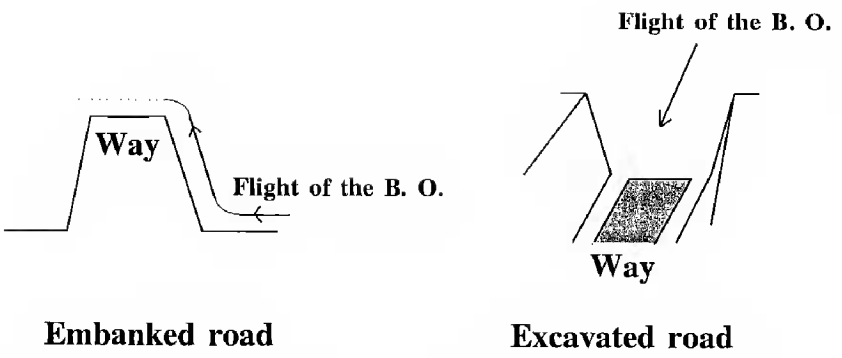

Figure 1. Schematic representation of two highway topographies. The arrow indicates the possible direction of flight of Barn Owls killed.

the side of the highway was classified according to the amount of hedge present (present, absent, and present/absent).

Factorial Correspondence Analysis (FCA) was used to determine which variables explained Barn Owl mortality. A variable highly correlated with one of the principal axes explains a large part of the inertia of this axis (STATITCF, Dervin 1988). Variables identified using this method were verified using χ^2 analysis. For this analysis, the proportion of birds killed in each class of the variable was compared to the kilometric proportion of the class along the highway (proportion of killed birds expected). Therefore, if a variable had no influence on Barn Owl mortality, the number of killed birds collected was the same as the expected number.

RESULTS

A total of 187 road-killed raptors was found representing three owl and one buzzard species. Of the owls, 148 were Barn Owls (86%), 15 Long-eared Owls (*Asio otus*), and 10 Tawny Owls (*Strix aluco*).

Although dead Barn Owls were not distributed evenly along the section of highway studied, on average we found about 1 Barn Owl/5 km of highway. The largest number (59%) was found along a small segment of the highway (23%) (Fig. 2). The direction of traffic did not seem to affect mortality but the majority of owls (55%) were found in the emergency stopping lane. Only a few individuals were found in the median strip (18%).

The results of FCA on the different variables measured indicated that the topography of the highway (mostly the excavated parts) and vegetation along the sides (present or absent) were important variables contributing 99.9% of the first principal component (A1, Fig. 3). Likewise, topography (principally level) and landscape (mainly forest) contributed to 96.4% of the second principal component (A2). Most of the owls were killed along embanked stretches of the highway that lacked roadside hedges and crossed open fields.

Comparison of the number of observed mortalities vs. those expected showed that mortalities did in fact increase along embanked highway stretches ($\chi^2 = 13.78$, $P < 0.05$) that crossed open fields ($\chi^2 = 26.99$, $P < 0.05$). Our findings were most significant when the highway stretch both lacked a hedge and was highly embanked ($\chi^2 = 4.82$, $P < 0.05$). The stretch of highway with the highest raptor mortality (59%) had the highest embankment and lacked hedges ($\chi^2 = 7.39$, $P < 0.05$). Fewer raptors (24%) were found dead in a stretch of the highway with both a high excavation and a hedge ($\chi^2 = 8.4$, $P < 0.05$).

DISCUSSION

Unlike Bourquin (1983) and Joveniaux (1986), who found most Barn Owls killed along highways

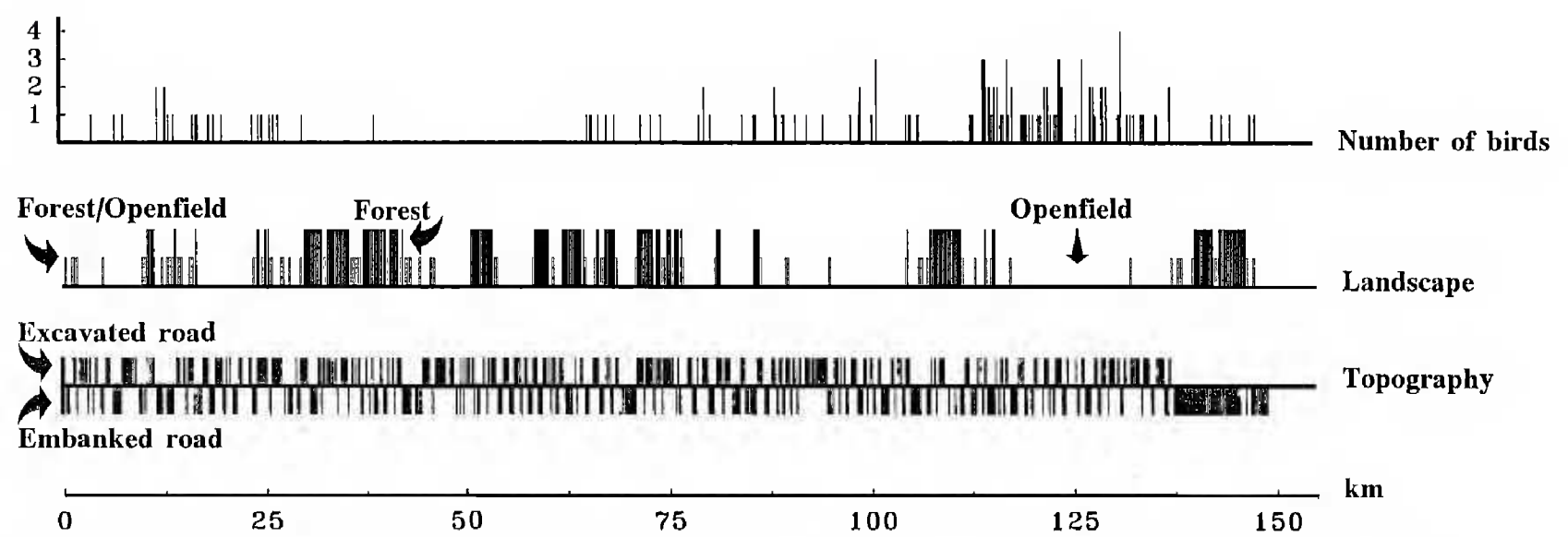

Figure 2. Spatial distribution of Barn Owl mortalities on the highway studied (Strasbourg-Metz). Number of raptors killed, topography, and landscape features are shown. The largest number of dead Barn Owls was found between kilometers 114–149.

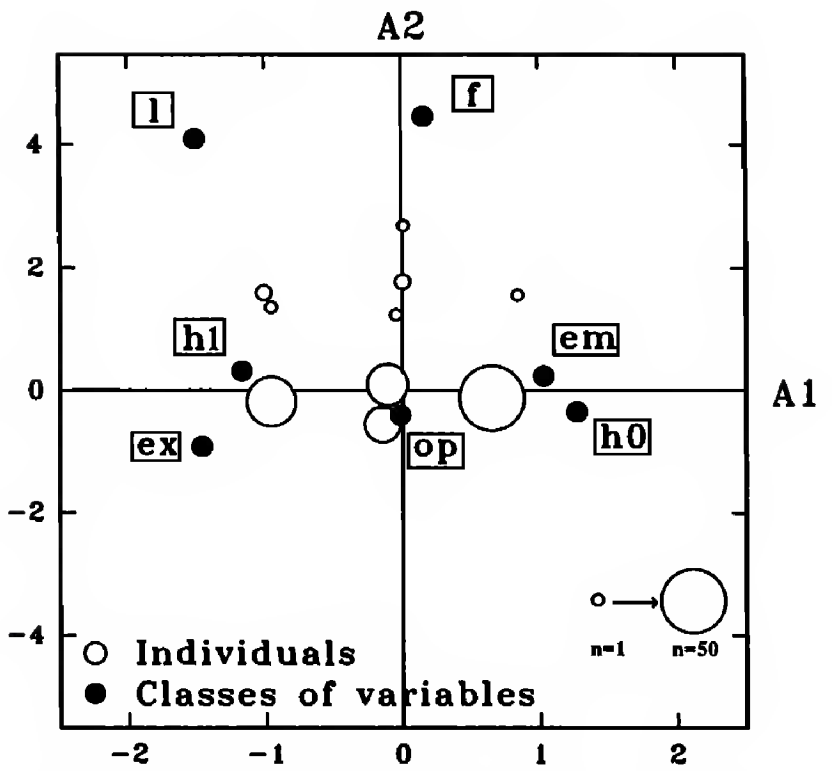

Figure 3. Biplot of the first two principal components of variables recorded at sites where Barn Owls were found killed by vehicles. The first (A1) and the second (A2) principal components explained 33% and 28% of the variance, respectively. Many individuals are on the same coordinates. To achieve a good representation of FCA, numbers are proportional to the diameter of the point (see scale in lower right corner). Forest/open field class (14% of total sector) is included in the open field class, embanked/excavated class (14% of total sector) is included in the embanked class, and the presence/absence of hedge class (15% of total sector) is included in the class presence of hedge. Symbols are as follows: landscape (forest [f] and open field [op]), togography (excavated road [ex], level [l], and embanked road [em]), and hedge (absence [h0] and presence [h1]).

crossing through forests, we found that Barn Owls were principally killed along sections of highway that crossed open fields. This may have been due to the fact that Barn Owls primarily hunt in open landscapes (Michelat and Giraudoux 1992) but it could also be related to the fact that Barn Owls killed along highways crossing through forests may have been attracted to excavated highway stretches that supported hedges on either side. These stretches support numerous small mammals that take refuge at the sides of highways and are undisturbed by agriculture (Spitz 1977, van der Reest 1992). Barn Owls typically prey on small mammals such as common voles (*Microtus arvalis*), woodmice (*Apodemus sylvaticus*), and common shrews (*Sorex araneus*) (Bourquin 1981, Baudvin et al. 1991). Because the sides of highways favor high winter densities of many of these species and make them more available because they are frequently snow-free (Bourquin 1983), these areas could potentially become traps for Barn Owls that are killed by passing vehicles.

Portions of embanked highway that crossed open fields also accounted for many of the Barn Owl mortalities. In this type of a situation, Barn Owls typically fly 2–5 m above the ground while hunting (Baudvin 1986), a height which corresponds to the normal height of passing trucks and cars. Barn Owls may cross embanked highways without climbing increasing the likelihood of impacts. Since we found most dead owls in the emergency lane of the highway, it appears that impacts probably occurred at the edges of the highway, when owls first started to cross the road. The amount of traffic probably had little effect on increasing the mortality (Canteneur 1964, Illner 1992) but the high speed of the traffic (>80 km/hr) probably did increase the danger for owls. It appeared that many of the owls were not killed by direct impact with vehicles but by impact with the ground after they were projected up into the air by turbulence behind vehicles.

We feel that few Tawny and Long-eared Owls were killed along this stretch of highway because they were simply less common in the area. The Tawny Owl is a woodland species and there was little forest habitat along this segment of highway. Likewise, few Long-eared Owls were known to occur in the area.

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